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UNITED STATES GOVERNMENT SPECIFICATION FOR
ZINC OXIDE, DRY AND PASTE.

FEDERAL SPECIFICATIONS BOARD.

STANDARD SPECIFICATION No. 8.

This Specification was officially adopted by the Federal Specifications Board on February 3, 1922, for the use of the Departments and Independent Establishments of the Government in the purchase of materials covered by it.

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1. GENERAL.

Zinc oxide may be ordered in the form of dry pigment or paste ground in linseed oil. Purchases shall be made on the basis of net weight.

The pigment may be American process zinc oxide, made direct from the ore, or French process zinc oxide, made from spelter. The contract shall state which kind is desired.

The color and color strength when specified shall be equal to samples mutually agreed upon by buyer and seller.

The pigment shall meet the following requirements:

	Maximum. Minimum.	
	Per cent.	Per cent.
Coarse particles retained on Standard No. 325 screen.....	1.0	
	American process.	
	Maximum.	Minimum.
	Per cent.	Per cent.
Zinc oxide.....		98
Total sulphur.....	0.2	
Total impurities, including moisture.....	2.0	
	French process.	
	Maximum.	Minimum.
	Per cent.	Per cent.
Zinc oxide.....		99
Total sulphur.....	0.1	
Total impurities, including moisture.....	1.0	

The paste shall be made by thoroughly grinding the above pigment with pure raw or refined linseed oil. The paste shall not cake in the container and shall break up readily in oil to form a smooth paint of brushing consistency.

The paste shall consist of:

	Maximum.	Minimum.
	Per cent.	Per cent.
Pigment.....	85	82
Linseed oil.....	15	14
Coarse particles and "skins" (total residue left on No. 325 screen based on pigment)	1.5	
Moisture and other volatile matter.....	0.5	

NOTE.—Deliveries will, in general, be sampled and tested by the following methods, but the purchaser reserves the right to use any additional available information to ascertain whether the material meets the specification.

2. SAMPLING.

It is mutually agreed by buyer and seller that a single package out of each lot of not more than 1,000 packages shall be taken as representative of the whole.

With the dry pigment, this package is to be opened by the inspector and a sample of not less than 5 pounds taken at random from the contents and sent to the laboratory for test. When requested, a duplicate sample may be taken from the same package and delivered to the seller, and the inspector may take a third sample to hold for test in case of dispute.

With the paste, whenever possible, an original unopened container shall be sent to the laboratory; and when this is for any reason not done, the inspector shall determine by thoroughly testing with a paddle or spatula whether the material meets the requirement regarding not caking in the container. (See 4 (a).) After assuring himself that the paste is not caked in the can, the

inspector shall draw a sample of not less than 5 pounds of the thoroughly mixed paste, place it in a clean, dry metal or glass container which must be filled with the sample, closed with a tight cover, sealed, marked, and sent to the laboratory for test with the inspector's report on caking in container.

3. LABORATORY EXAMINATION OF DRY PIGMENT.

(a) COLOR.—Take 5 g of the sample, add 1.5 cc of linseed oil, rub up on a stone slab or glass plate with a flat-bottomed glass or stone pestle or muller to a uniform smooth paste. Treat in a similar manner 5 g of the standard zinc oxide. Spread the two pastes side by side on a clear colorless glass plate and compare the colors. If the sample is as white as or whiter than the "standard," it passes this test. If the "standard" is whiter than the sample, the material does not meet the specification.

(b) COLOR STRENGTH.—Weigh accurately 0.01 g of lampblack, place on a large glass plate or stone slab, add 0.2 cc of linseed oil and rub up with a flat-bottomed glass pestle or muller, then add exactly 10 g of the sample and 2.5 cc of linseed oil, and grind with a circular motion of the muller 50 times; gather up with a sharp-edged spatula and grind out twice more in a like manner, giving the pestle a uniform pressure. Treat another 0.01 g of the same lampblack in the same manner except that 10 g of standard zinc oxide is used instead of the 10 g of the sample. Spread the two pastes side by side on a glass microscope slide and compare the colors. If the sample is as light as or lighter in color than the "standard," it passes this test. If the "standard" is lighter in color than the sample, the material does not meet the specification.

(c) COARSE PARTICLES.¹—Dry in an oven at 105 to 110° C. a 325 screen, cool and weigh accurately. Weigh 10 g of the sample; dry at 100° C., transfer to a mortar, add 100 cc kerosene, thoroughly mix by gentle pressure with a pestle to break up all lumps, wash with kerosene through the screen, breaking up all lumps, but not grinding. After washing with kerosene until all but the particles which are too coarse to pass the screen have been washed through, wash all kerosene from the screen with ether or petroleum ether, heat the screen for one hour at 105 to 110° C., cool and weigh.

¹ For a general discussion of screen tests of pigments and data regarding many pigments on the market, see Circular No. 148 of the Educational Bureau, Scientific Section, Paint Manufacturers' Association of the United States.

(d) **QUALITATIVE ANALYSIS.**—Test for matter insoluble in hydrochloric acid, for lead, calcium, etc., by regular methods of qualitative analysis.

(e) **ZINC OXIDE.**—With samples free from impurities (see (d)), ignite a weighed sample and calculate the residue as ZnO. With samples containing impurity, proceed as follows: Weigh accurately about 0.25 g, transfer to a 400 cc beaker, moisten with alcohol, dissolve in 10 cc of hydrochloric acid and 20 cc of water and titrate with standard potassium ferrocyanide following the procedure used in standardizing this reagent. (See 5(i).)

(f) **TOTAL SULPHUR.**—Weigh accurately about 10 g of the sample. Moisten with a few drops of alcohol, add 5 cc of bromine water (saturated solution of bromine), then concentrated hydrochloric acid in excess, boil to expel bromine, and dilute to about 100 cc. (Material complying with the specification should all go into solution; if insoluble matter remains, filter and examine by appropriate methods.) Make alkaline with ammonia, then just acid with hydrochloric acid, heat to boiling and add about 10 cc of hot barium chloride solution. (See Reagents.) Let stand several hours (overnight), filter on a weighed Gooch crucible, wash thoroughly with hot water, dry, ignite, cool, and weigh the BaSO₄. Calculate to S ($\text{BaSO}_4 \times 0.1373 = S$).

4. LABORATORY EXAMINATION OF PASTE.

(a) **CAKING IN CONTAINER.**—When an original package is received in the laboratory, it shall be weighed, opened, and stirred with a stiff spatula or paddle. The paste must be no more difficult to break up and show no more caking than a normal good grade of zinc oxide paste. The paste shall be finally thoroughly mixed, removed from the container, the container wiped clean, and weighed. This weight subtracted from the weight of the original package gives the net weight of the contents. A portion of the thoroughly mixed paste shall be placed in a clean container and the portions for the remaining tests promptly weighed out.

(b) **MIXING WITH LINSEED OIL.**—One hundred grams of the paste shall be placed in a cup, 35 cc of linseed oil added slowly with careful stirring and mixing with a spatula or paddle. The resulting mixture must be smooth and of good brushing consistency.

(c) **MOISTURE AND OTHER VOLATILE MATTER.**—Weigh accurately from 3 to 5 g of the paste into a tared flat-bottomed dish, about 5 cm in diameter, spreading the paste over the bottom.

Heat at 105 to 110° C. for one hour, cool, and weigh. Calculate loss in weight as percentage moisture and other volatile matter.

(d) **PER CENT PIGMENT.**—Weigh accurately about 15 g of the paste into a weighed centrifuge tube. Add 20 to 30 cc of “extraction mixture” (see Reagents), mix thoroughly with a glass rod, wash the rod with more of the extraction mixture, and add sufficient of the reagent to make a total of 60 cc in the tube. Place the tube in the container of a centrifuge, surround with water, and counterbalance the container of the opposite arm with a similar tube or a tube with water. Whirl at a moderate speed until clear. Decant the clear supernatant liquid. Repeat the extraction twice with 40 cc portions of extraction mixture, and once with 40 cc of ether. After drawing off the ether, set the tube in a beaker of water at about 80° C. or on top of a warm oven for 10 minutes, then in an oven at 110 to 115° C. for 2 hours. Cool, weigh, and calculate percentage of pigment.

(e) **EXAMINATION OF PIGMENT.**—Grind the pigment from (d) to a fine powder, pass through a No. 80 screen to remove any “skins,” preserve in a stoppered tube and apply tests 3 (d), (e), and (f). If required, apply tests 3 (a) and (b) in comparison with a portion of pigment extracted from the standard paste in exactly the same manner as in extracting the sample.

(f) **PREPARATION OF FATTY ACIDS.**—To about 25 g of the paste in a porcelain casserole add 15 cc aqueous sodium hydroxide (see Reagents), and 75 cc of ethyl alcohol, mix and heat uncovered on a steam bath until saponification is complete (about one hour). Add 100 cc water, boil, add an excess of sulphuric acid of specific gravity 1.2 (8 to 10 cc will usually suffice), boil, stir, and transfer to a separatory funnel to which some water has been previously added. Draw off as much as possible of the acid aqueous layer, wash once with water; then add 50 cc of water and 50 cc of ether. Shake very gently with a whirling motion to dissolve the fatty acids in the ether, but not violently, so as to avoid forming an emulsion. Draw off the aqueous layer and wash the ether layer with one 15 cc portion of water and then with 5 cc portions of water until free from sulphuric acid. Then draw off completely the water layer. Transfer the ether solution to a dry flask, and add 25 to 50 g of anhydrous sodium sulphate. Stopper the flask and let stand with occasional shaking at a temperature below 25° C. until the water is completely removed from the ether solution, which will be shown by the solution becoming perfectly clear

above the solid sodium sulphate. Decant this clear solution (if necessary through a dry filter paper) into a dry 100 cc Erlenmeyer flask. Pass a rapid current of dry air (pass through CaCl_2 tower) into the mouth of the Erlenmeyer flask and heat to a temperature below 75°C . on a dry hot plate until the ether is entirely driven off.

NOTE.—It is important to follow all of the details, since ether generally contains alcohol and after washing with water always contains water. It is very difficult to remove water and alcohol by evaporation from fatty acids, but the washing of the ether solution and subsequent drying with anhydrous sodium sulphate removes both water and alcohol. Ether, in the absence of water and alcohol, is easily removed from fatty acids by gentle heat.

The fatty acids prepared as above should be kept in a stoppered flask and examined at once.

(g) TEST FOR MINERAL OIL AND OTHER UNSAPONIFIABLE MATTER.—Place 10 drops of the fatty acid (f) in a 50 cc test tube, add 5 cc of alcoholic soda (see Reagents), boil vigorously for 5 minutes, add 40 cc of water, and mix; a clear solution indicates that not more than traces of unsaponifiable matter are present. If the solution is not clear, the oil is not pure linseed oil.

(h) IODINE NUMBER OF FATTY ACIDS.—Place a small quantity of the fatty acids (f) in a small weighing burette or beaker. Weigh accurately. Transfer by dropping about 0.15 g (0.10 to 0.20 g) to a 500 cc bottle having a well-ground glass stopper, or an Erlenmeyer flask having a specially flanged neck for the iodine test. Reweigh the burette or beaker and determine the amount of sample used. Add 10 cc of chloroform. Whirl the bottle to dissolve the sample. Add 10 cc of chloroform to two empty bottles like that used for the sample. Add to each bottle 25 cc of the Hanus solution (see Reagents) and let stand, with occasional shaking, for one-half hour. Add 10 cc of the 15 per cent potassium-iodide solution and 100 cc of water, and titrate with standard sodium thiosulphate, using starch as indicator. The titrations on the two blank tests should agree within 0.1 cc. From the difference between the average of the blank titrations and the titration on the sample and the iodine value of the thiosulphate solution, calculate the iodine number of the sample tested. (Iodine number is centigrams of iodine to 1 g of sample.) If the iodine number is less than 170, the oil does not meet the specification.

(i) COARSE PARTICLES AND "SKINS."—Weigh an amount of paste containing 10 g of pigment (see 4 (d)), add kerosene, and wash through a No. 325 screen as in 3 (c). The residue is reported as "Coarse particles and skins."

5. REAGENTS.

(a) EXTRACTION MIXTURE.—

10 volumes ether (ethyl ether).

6 volumes benzol.

4 volumes methyl alcohol.

1 volume acetone.

(b) AQUEOUS SODIUM HYDROXIDE.—Dissolve 100 g sodium hydroxide in distilled water and dilute to 300 cc.

(c) STANDARD SODIUM THIOSULPHATE SOLUTION.—Dissolve pure sodium thiosulphate in distilled water that has been well boiled to free it from carbon dioxide, in the proportion of 24.83 g crystallized sodium thiosulphate to 1,000 cc of the solution. It is best to let this solution stand for about two weeks before standardizing. Standardize with pure resublimed iodine. (See Analytical Chemistry, Treadwell-Hall, vol. 11, 3d ed., p. 646.) This solution will be approximately decinormal, and it is best to leave it as it is after determining its exact iodine value rather than to attempt to adjust it to exactly decinormal. Preserve in a stock bottle provided with a guard tube filled with soda lime.

(d) STARCH SOLUTION.—Stir up 2 to 3 g of potato starch or 5 g soluble starch with 100 cc of 1 per cent salicylic acid solution, add 300 to 400 cc boiling water, and boil the mixture until the starch is practically dissolved, then dilute to 1 liter.

(e) POTASSIUM IODIDE SOLUTION.—Dissolve 150 g of potassium iodide free from iodate in distilled water and dilute to 1,000 cc.

(f) HANUS SOLUTION.—Dissolve 13.2 g of iodine in 1,000 cc of 99.5 per cent glacial acetic acid which will not reduce chromic acid. Add enough bromine to double the halogen content, determined by titration (3 cc of bromine is about the proper amount). The iodine may be dissolved by the aid of heat, but the solution should be cold when the bromine is added.

(g) ALCOHOLIC SODIUM HYDROXIDE SOLUTION.—Dissolve pure sodium hydroxide in 95 per cent ethyl alcohol in the proportion of about 22 g per 1,000 cc. Let stand in a stoppered bottle. Decant the clear liquid into another bottle and keep well stoppered. This solution should be colorless or only slightly yellow when used, and it will keep colorless longer if the alcohol is previously treated with sodium hydroxide (about 80 g to 1,000 cc), kept at about 50° C. for 15 days and then distilled.

(h) URANYL INDICATOR FOR ZINC TITRATION.—A 5 per cent solution of uranyl nitrate in water or a 5 per cent solution of uranyl acetate in water made slightly acid with acetic acid.

(i) STANDARD POTASSIUM FERROCYANIDE.—Dissolve 22 g of the pure salt in water and dilute to 1,000 cc. To standardize transfer about 0.2 g (accurately weighed) of pure metallic zinc or freshly ignited pure zinc oxide to a 400 cc beaker. Dissolve in 10 cc hydrochloric acid and 20 cc water. Drop in a small piece of litmus paper, add ammonium hydroxide until slightly alkaline, then add hydrochloric acid until just acid, and then add 3 cc strong hydrochloric acid. Dilute to about 250 cc with hot water and heat nearly to boiling. Run in the ferrocyanide solution slowly from a burette with constant stirring until a drop tested on a white porcelain plate with a drop of the uranyl indicator shows a brown tinge after standing one minute. A blank should be run with the same amounts of reagents and water as in the standardization. The amount of ferrocyanide solution required for the blank should be subtracted from the amounts used in standardization and in titration of the sample. The standardization must be made under the same conditions of temperature, volume, and acidity as obtain when the sample is titrated.

(j) BARIUM CHLORIDE SOLUTION.—Dissolve 100 g of pure crystallized barium chloride in water and dilute to 1,000 cc.

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